Contribution ID: **603** Type: **Poster**

Relativistic meson-exchange currents in semi-inclusive lepton scattering

Friday, 21 June 2024 17:30 (2 hours)

The control of nuclear effects is crucial to guarantee the success of future neutrino oscillation experiments (HyperK
and DUNE) in the search of CP violation in the leptonic sector. In particular, recently published semi-inclusive measurements are very sensitive to the details of nuclear modeling.

Among the various processes contributing to the cross section, two-particle–two-hole (2p2h) excitations induced by meson-exchange currents are particularly relevant and difficult to model.
Presently, this process is implemented in Monte Carlo generators on the basis of {\it inclusive} calculations. This procedure involves assumptions and approximations difficult to control. The correct approach to implement a 2p2h model event generators for the {\it semi-inclusive} reaction is through a microscopic calculation of these contributions, which was so far missing in the literature.

In this work we assess for the first time the impact of 2p2h excitations on the semi-inclusive neutrino scattering process (ν_l, lN), using a fully relativistic nuclear model calculation that precisely incorporates antisymmetrization. The calculation encompasses all contributions involving the exchange of a single pion and the excitation of a Δ resonance. Our results are coherent with previous inclusive electron scattering [1] and neutrino scattering [2] studies and are tested in the electromagnetic sector. Comparisons with $(e, e'p)$ data on carbon at kinematics where two-nucleon emission dominates are presented [3], as well as predictions for semi-inclusive neutrino scattering.

[1] A. De Pace, M. Nardi, W.M. Alberico, T.W. Donnelly, A. Molinari, The 2p - 2h electromagnetic response in the quasielastic peak and beyond, Nucl.Phys.A 726 (2003), 303-326
[2] I. Ruiz Simo, J. E. Amaro, M. B. Barbaro, A. De Pace, J. A. Caballero and T. W. Donnelly, Relativistic model of 2p-2h meson exchange currents in (anti)neutrino scattering,'
J. Phys. G \textbf{44} (2017) no.6, 065105
[3] V. Belocchi, M. B. Barbaro, A. De Pace and M. Martini,
Relativistic meson-exchange currents in semi-inclusive lepton scattering, submitted to PRL [arXiv:2401.13640 [nucl-th]]

Poster prize

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Session Classification: Poster session and reception 2

Track Classification: Neutrino interactions